

Design and Implementation of Expert System in Irrigation of Sugarcane: Conceptual Study

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Abstract — Indian economy is an agro based economy. But Indian agriculture depends on monsoon which is always fluctuating. Hence effective irrigation management is required in case of water intensive crops such as Sugarcane. The proposed research work deals with the analysis of irrigation problems of sugarcane in Kolhapur division. The research will be conducted for evaluation of possible irrigation methods. Through this research work, Researcher wants to design and implement knowledge based expert system for automation of drip irrigation for efficient irrigation of Sugarcane.

Keywords — Sugarcane, Irrigation analysis, Expert System, Drip irrigation

I. INTRODUCTION

Indian economy is an agro based economy. More than 70% population based on agricultural for its subsistence. But Indian agriculture depends on monsoon which is always fluctuating. Maharashtra accounts for nearly 9% of the total agricultural income of the country and it is India's second largest sugar-producing state. Sugarcane is one of the most water-intensive crops consumes around 70% of the total water available through the irrigation system for farming in the state. The water resources are scarce, therefore improved methods of water management is imperative.

New irrigation methods such as sprinkle and drip irrigation are found to be very effective compared to conventional methods. Currently farmers deals with these methods manually which sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Plant water requirement is depend on various parameters such as soil characteristics, humidity and temperature which often change. To analyze exact water requirement some kind of expertise is required. This problem can be perfectly rectified with recent developments in information technology, specifically the new capabilities of software development efforts associated with Artificial Intelligence (Rich, 1983), known as Expert system for irrigation and thereby control irrigation problems.

The proposed research work deals with the analysis of irrigation problems of sugarcane in Kolhapur division. The research will be conducted for evaluation of possible irrigation methods. Through this research work, Researcher wants to

design and implement knowledge based expert system for automation of drip irrigation for efficient irrigation of Sugarcane.

A. Expert System

Expert System, also referred as knowledge based systems, is one of the important application branches of Artificial Intelligence. This is a computer application that performs a task that would otherwise be performed by a human expert.

Expert systems of today support many problem solving activities such as decision making, knowledge fusing, designing, and planning, forecasting, regulating, controlling, monitoring, identifying, diagnosing, prescribing, interpreting, explaining, training etc. using different techniques and it is expected that future expert systems will support even more activities.

B. Expert System Technology

Expert system consists of Knowledge-base (language for encoding knowledge) and Inference engine (algorithms for reasoning). In rule based expert System. Tools for Developing an Expert System consists of Programming languages, Shells for rule set manager (software for building, maintaining, and compiling rule sets) and inference engine(algorithms for reasoning) and Integrated environments(shells capabilities integrated with other computing capabilities into a single tool).

A rule consists of two parts: condition (antecedent) part and conclusion (action, consequent) part, i.e: IF (conditions) THEN (actions). Antecedent part of the rule describes the facts or conditions that must exist for the rule to fire.

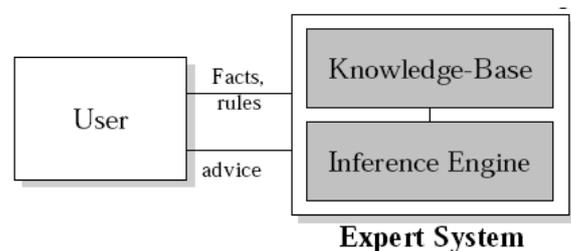


Fig. 1 Components of Expert System

C. Importance of Expert Systems in Agriculture

Expert systems have been applied increasingly for agricultural fields in recent years. Agricultural production has

evolved into a complex business which requires the accumulation and integration of knowledge and information from many diverse sources. For decision making the modern farmer often relies on agricultural specialists and advisors for providing critical information. Agricultural specialist assistance is not always available when the farmer needs it. Hence, Expert Systems were identified as powerful tool with extensive potential in agriculture. Knowledge based agricultural Expert System becomes more powerful since it collects expertise from not one, but a number of experts. Expert systems combine the experimental and experiential knowledge with the intuitive reasoning skills of a multitude of specialists to aid farmers in making the best decisions for their crops. The modern time agriculture requires information and application of knowledge from different interacting fields of science and engineering to do appropriate decision-making.

Thus the Expert Systems can act as powerful tools of agricultural extension which will be of immense utility to the extension functionaries in timely transfer of information and technologies and efficient problem solving, which in turn will be highly beneficial to the farming community.

II. REVIEW OF LITERATURE

S. Kamala, in her paper entitled "Embedded Systems-Drip Irrigation,"¹ has explained the concept of microcontroller based dripped irrigation systems. The paper also focuses on the design methodology and its construction.

G.N.R. Prasad and Dr. A. Vinaya Babu in the paper entitled "PANI *: An Expert System for Irrigation Management"² deals with the suitability of application of expert system technology in agriculture and proposes the development of rule-based expert system name PANI, for the effective irrigation management of the crop. The proposed system uses the knowledge of only one parameter i.e. moisture levels in the soil to get the time of irrigation. The system has been developed in the Visual Basic 6.0 environment.

Sudeep Marwaha³ in his paper entitled "Online expert system in agriculture" has given the information about Agridaksh developed by Indian Agriculture Statistics research Institute in collaboration with Directorate of Maize Research, New Delhi. This system provides ICT based advisories on Maize crop and allows interaction with experts through Internet.

ICAR also have Launched similar ICT enabled 'Expert System on Agriculture and Animal Husbandry Enterprises'.²¹ The major outcome of this project is the ICT enabled knowledge module comprising of decision support system, information system, plant doctor for paddy, coconut, ragi, banana, sugarcane and health advisor regards dairy cattle, poultry and ATM of the farmers sheep and goat in multilingual i.e. English, Tamil, Kannada and Malayalam.

A research paper "Decision Support Systems in Agriculture: Some Successes and a Bright Future"⁵ of Russell Yost, Tasnee Attanandana, Carol J. Pierce Colfer and Stephen Itoga presented a list of various decision aids developed and

illustrate the range of uses, methods of implementation, purposes as well as unexpected benefits.

Boshra Rajaei, Mohsen Kahani, reviews recent advances in expert systems for agricultural activities such as planting activities, planting to harvest activities and after harvesting processes in the paper entitled "Agricultural Expert Systems"⁶. In this paper many experts systems and their specifications are discussed.

Rajkishore Prasad, Dr. Ashok Kumar Sinha in their paper entitled "Role of Expert System in Natural Resources Management"¹⁰ presents essentials of design and development technology of expert system and their application in the natural resource like land; water, minerals, forests, fisheries and livestock database management to facilitate the remote sensing applications.

S. Sivakami and C.Karthikeyan in their paper entitled "Evaluating the Effectiveness of Expert System for Performing Agricultural Extension Services in India"¹¹ presented research study that was carried out to assess the effect of using expert system on the performance and decision making skill of the extension personnel after using the expert system on maize. The Paper talks about feasibility of using an expert system as a decision support tool for transfer of agricultural technologies to the farming community.

Concluding Remark:

Although the literature presents the research already conducted in variety of areas of applications of Expert System in Agriculture, the proposed research will primarily focus on analysis of irrigation problems for sugarcane in Kolhapur division particularly. This area has remained grossly untouched from the research perspective. Therefore the researcher is attempting to conduct the research in this particular area.

III. STATEMENT OF PROBLEM

Agricultural production has evolved into a complex business which requires the accumulation and integration of knowledge and information from many diverse sources. Expert systems have been applied increasingly for agricultural fields in recent years for solving most of the problems.

The major intention of the researcher is to identify irrigation problems faced by the farmers while cultivating the Sugarcane. Researcher wants to design, develop and implement an expert system based on knowledge base which will be designed using experimental and experiential knowledge in agriculture field. Therefore researcher desired to attempt "DESIGN AND IMPLEMENTATION OF EXPERT SYSTEM IN IRRIGATION OF SUGARCANE IN KOLHAPUR DIVISION." for the proposed study.

IV. SIGNIFICANCE OF STUDY

Expert systems are intended to combine the experimental and experiential knowledge with the intuitive reasoning skills of a multitude of specialists to aid farmers in automating various agricultural activities. The modern time agriculture requires information and application of knowledge from different interacting fields of science and engineering to do

appropriate decision-making. The proposed study is important particularly from the perspective of the agriculturists who are producing sugarcane. Apart from this, the policy makers, particularly government and other local authorities can also take the appropriate decisions about various aspects involved in irrigation and other associated problems of the sugarcane growing farmers. The proposed study is an attempt in this direction to solve the issues faced by these farmers.

V. JUSTIFICATION OF PROBLEM

Agriculture has progressed a long way in India from an era of frequent droughts and vulnerability to food shortages, to become a significant exporter of a diversified basket of agricultural commodities. Maharashtra accounts for nearly 9% of the total agricultural income of the country and it is India's second largest sugar-producing state. But Indian agriculture depends on monsoon which is always fluctuating. Sugarcane, one of the most water-intensive crops, requires 10 times more water than jowar or nut and around 80% is ironically grown in regions that have a history of water scarcity. Approximately 25,000 kg of water is needed to produce 10 kg of sugarcane. The area under cultivation for sugarcane is only around 16% of the total cultivable land in the state, according to a 2005 World Bank report, but sugarcane consumes around 70% of the total water available through the irrigation system for farming in the state. It blames the proliferation of sugarcane farming for the lack of availability of water in dams and rivers and depleting ground water levels. Not only does it capture maximum water, it results in water logging, salinity and severe water pollution by sugar factories. Large parts of Maharashtra are drought prone. The water resources are scarce, therefore improved methods of water management is imperative.

Following the 2005 World Bank report, the Maharashtra government created an independent water regulator for the sector called the Maharashtra Water Resource Regulatory Authority (MWRRA), which recommended that area under sugarcane cultivation, should not exceed 10% of the total command area (portion irrigated) of any dam. After the severe drought of 2012-13, the Maharashtra state government is planning to make it mandatory for sugarcane growers to use drip irrigation systems over the next three years, a move prompted by the drought.

The implementation of drip irrigation and fertigation in sugar cane has proved to be technically feasible and economically viable. In many diverse agro-ecological situations, drip irrigation registered higher yields (50 to 90 tons/ha), conservation of water (30 to 45%) and fertilizers (25 to 30%). Furthermore, drip irrigation accounts for the improvement in sucrose content compared to conventional furrow. At present, the farmers have been using irrigation technique in Maharashtra through the manual control in which the farmers irrigate the land at the regular intervals. This process sometimes consumes more water or sometimes the water reaches late due to which the crops get dried. Also plant water requirement is depend on various parameters such as soil characteristics, humidity and temperature which often change. Farmers manually deal with these parameters which will

require some kind of expertise to analyze exact water requirement. This problem can be perfectly rectified with Recent developments in information technology, specifically the new capabilities of software development efforts associated with Artificial Intelligence (Rich, 1983), known as Expert system for irrigation and thereby control drip irrigation.

Hence it is necessary to analyze irrigation problem of sugarcane in Kolhapur division and study how expert system solution can be applied so as to minimize those problems.

VI. OBJECTIVES OF THE STUDY

Following objectives has been formulated for the proposed study,

- To identify the irrigation problems of Sugarcane.
- To study various Irrigation methods.
- To design knowledge base for Expert System
- To develop and implement Expert System
- To analyze post implementation applications, problems and prospects of Expert System
- To study comparative analysis of applications of Expert System in irrigation and conventional irrigation.

VII. HYPOTHESES

Following hypotheses has been formulated for the proposed study,

- Irrigation problems faced by farmers vary from one district to another district.
- The irrigation problems faced due to conventional irrigational methods can be minimized using Expert System irrigation method.

VIII. RESEARCH METHODOLOGY

The proposed study is an exploratory study to identify irrigation problems of Sugarcane faced by the farmers while cultivating the Sugarcane and suggest application of Expert System in order to provide solution to these problems.

A. Data Collection

- 1) *Primary Data:* The primary data related to the proposed study will be collected using questionnaire from farmers, Officials in irrigation departments and experts in related field. The data will be presented in tabular and graphical form. Appropriate statistical techniques will be applied to process data and conclusion and suggestions will be drawn.
- 2) *Secondary Data:* The secondary data - Published Reports, Periodicals, News papers and Internet etc, - will also be used for the proposed research work.

B. Sample Design

Following table gives an idea about area, production, productivity and no. of farmers engaged in production of sugarcane Kolhapur division.

In order to understand the problems associated with irrigation, it is necessary to conduct personal interviews of sugarcane growers, irrigation departments of sugarcane

factories and experts in this filed. Since the population of farmers in three districts is infinite (population is greater than 50,000), following equation is used to finalize the sample size of farmers.

$$SS = \frac{Z^2 \times (p) \times (1 - p)}{C^2}$$

SS = Sample Size

Z = Z-value represent the probability that a sample will fall within a certain distribution. (e.g., 1.96 for a 95 percent confidence level)

P = Percentage of population picking a choice, expressed as decimal (0.5)

C = Confidence interval, expressed as decimal (e.g., .05 = +/- 5 percentage points)

$$SS = \frac{3.8416 \times .5 \times .5}{.0025}$$

$$SS = 384.16$$

i.e. approximately 385 respondents will be taken

There are 30 irrigation departments in three districts which is finite (population is less than 50,000), following equation is used to finalize the sample size.

$$\text{New SS} = \frac{SS}{(1 + (SS - 1)) / \text{Pop}}$$

Pop = Population

$$\text{New SS} = \frac{385}{(1 + (385 - 1)) / 30}$$

$$\text{New SS} = 27$$

10 Experts from Kolhapur division through convenient sampling will be selected from respected field.

C. Analysis of Data

The data will be analyzed by using simple mathematical tools and softwares.

IX. CONCLUSION

There is need of effective sugarcane irrigation problem analysis and providing solution thereby. Expert system solutions can be provided for effective irrigation management. The proposed research work will definitely help to analyse irrigation problems of sugarcane in Kolhapur division. The research will be conducted for evaluation of possible irrigation methods. Through this research work, a knowledge based expert system will be designed and developed for automation of drip irrigation for efficient irrigation of Sugarcane.

X. REFERENCES

1. S. Kamala, "Embedded Systems-Drip Irrigation," Proceeding of ICRTiCA13, Organized by Hindustan college of Arts and Commerce, ISBN-978-93-81208-25-0, pp. 77, September 2013.
2. G.N.R. Prasad, Dr. A. Vinaya Babu "PANI * : An Expert System for Irrigation Management" Georgian Electronic Scientific Journal: Computer Science and Telecommunications 2007
3. Sudeep Marwaha "Online expert system in agriculture" Indian Agriculture Statistics research Institute, New Delhi -11012
4. Training Manual on Sustainable Sugarcane Initiative: Improving Sugarcane Cultivation in India, An Initiative of ICRISAT-WWF Project, ICRISAT .Patancheru - 502 324, Andhra Pradesh, India
5. Russell Yost, Tasnee Attanandana, Carol J. Pierce Colfer and Stephen Itoga (2011). Decision Support Systems in Agriculture: Some Successes and a Bright Future, Efficient Decision Support Systems – Practice and Challenges From Current to Future, Prof. Chiang Jao (Ed.), ISBN: 978-953-307-326-2,
6. Boshra Rajaei , Mohsen Kahani,"Agricultural Expert Systems" Research Journal of Biological Sciences, Year (2008-12).
7. S S Kalamkar, "Patterns and Determinants of Agricultural Growth in Maharashtra,"
8. D Ratna, M Teeluck and D Ah-Koon "Improving Use of Limited Water by Sugar Cane," Mauritius Sugar Industry Research Institute
9. S. Sivakami and C.Karthikeyan , "Evaluating the Effectiveness of Expert System for Performing Agricultural Extension Services in India" International Journal of Expert Systems with Applications vol 36 Issue 6, August, 2009, 9634 -9636
10. Rajkishore Prasad, Dr. Ashok Kumar Sinha, Role of Expert System in Natural Resources Management
11. Huirne, R.B.M., A.A. Dijkhuizen, J.A. Renkema & P. Van Beek (1995).